



Breeding Operations
Network for Development

excellenceinbreeding.org/BOND



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Agenda

- **Special guest intro** – Jan Debaene
- **BOND concept** – Gustavo Teixeira
- **Breeding Operations at IITA – Current Scenario and opportunities;** Alick Mulenga, head of breeding operations at IITA
- **Bayer: Seed Production and pipeline delivery;** Gawie Groenewald (BAYER)
- **Q&A**





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*Jan Debaene, EiB Deputy Director
9th June, 2021*

EiB Purpose

To increase impact of CGIAR and NARS breeding to contribute to achieving the goal of world without hunger or malnutrition by 2030 and to reduce poverty.



The 6 funders' requests



1. Align breeding pipelines with market segments, develop pipeline investment cases, product profiles, etc.
2. Incentivize management and staff to deliver higher genetic gain.
3. Develop strategic plans for varietal turnover.
4. Quantitatively optimize pipelines to increase genetic gain.
5. Implement shared services.
6. Build NARS breeding networks and capacity.

Vision for CGIAR breeding



That CGIAR-NARS breeding networks generate rates of genetic gain $\geq 1.5\%$ p.a. and that the average area weighted age of varieties in farmers' fields is < 10 years



Detailed vision for CGIAR breeding:

<https://excellenceinbreeding.org/sites/default/files/u107/EiB%20Vision%20for%20CGIAR%20Breeding.pdf>



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The focus of breeding operations



1. Accuracy – site selection, management, mechanization, consistency and quality
2. Throughput – number of quality data points, and speed / turnaround time
3. Cost per operation or data point – first determine the costs, then using continuous improvement principles, drive down the cost without sacrificing quality



How does this drive genetic gain?



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The role of operations in context of genetic gains



High quality phenotypic data is cornerstone of any breeding program.

$$\Delta G_{year} = \frac{i r_{AI} \sigma_A}{L}$$

Drivers of genetic gain:

- **Accuracy**
- **Breeding cycle time**: Time taken to develop a cohort of new lines and test sufficiently to select best for recycling as a parent
- **Selection intensity** (size of program / number of parents selected)
- Genetic diversity



Accuracy

There are a number of ways to increase accuracy:

- Reducing sources of error and unwanted variation (plotmanship, consistency, digital data capture and QA/QC)
- Identification of errors and misses (ex.: unsuccessful crosses or contamination): apply continuous improvement principles
- Increase representativeness of TPE's
 - Predictive ability of selection environment for target population of environments → Managed environments
 - More environments, especially in early generations.
- Increased number of plots over more locations – reducing **costs** enables more data points → increased accuracy



Breeding cycle time



Primarily depends on three factors:

- Line development time; time from cross to testing
 - **Throughput**. This is purely an operational and logistics challenge.
- Accurate data enabling parents to be identified earlier
 - **Accuracy** is determined by operations
- All traits on product profile tested early in pipeline
 - **Throughput and cost**. This is the intersection of throughput, cost and logistics; all determined by operations

Selection intensity



Is influenced by two factors:

1. Number of lines tested

- This is a function of **throughput and cost** which are operational issues. High throughput and low cost per datapoint allow more lines to be tested.



2. Number of parents selected

- Breeders can only reduce the number of parents selected if they are making selections based on highly **accurate** data

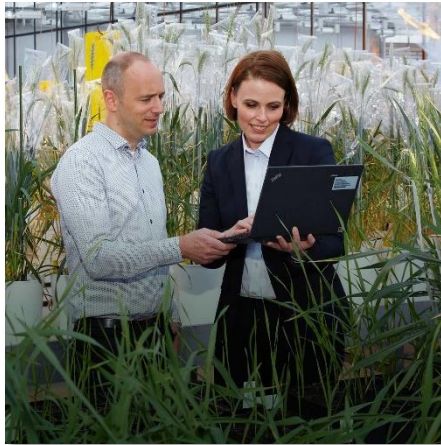
Operations are the cornerstone of genetic gain

By optimizing accuracy, throughput and cost you enable breeding teams to significantly increase rates of genetic gain.

Simulations with CGIAR programs have shown that increased accuracy and throughput will enable breeders to shorten breeding cycle times and improve selection of parents that will result in a up to a 4 fold increase in genetic gain!



Thank you!



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Why are you here?



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What is the vision?



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“...breeding programs have the most effective and cost efficient phenotypic process, from field preparation to data collection. With a strong culture of delivery of quality data through continuous improvement. Providing respect and safety for all employees”.

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Annual Meeting 2019

Pillars of a world-class breeding program

- Focus on developing products and adoption for impact**
 - Double the rate of genetic gain
 - All breeding activities are targeted by clear **targeted product profiles** that define customer and their needs.
 - **Target market segments** are defined and linked to distinct germplasm pools and breeding schemes.
- Optimized breeding schemes**
 - Variety development, parent development, identification and validation of novel genetic diversity are **distinct and separate activities**.
 - **Breeding cycles** are shortened towards to the biological limit.
 - A **stage gate system** is implemented to manage breeding activities.
- Data accuracy, cost & throughput**
 - Appropriate use of technology to increase genetic gain per dollar invested
 - Selections made on **high-quality trials**
 - Continuous and accurate **data collection**
 - Current best practice data management and quality control
 - **Breeding costs** known and readily retrieved
- Crossing linked to breeding strategy**
 - Parental selections made and genetic diversity managed according to the **breeding strategy**
 - Variety development strictly based on **elite-by-elite crosses**
 - **Genetic diversity** is measured and actively managed
- Maximized evaluation accuracy**
 - **Genetic gains assessed annually**
 - Best practice implementation of **trial designs**
 - Reliable generation of data representative of **targeted population of environments** to select parents earlier
 - Latest **phenotyping and envirotyping** technologies evaluated
- Accurate selection**
 - **Annual advancement meeting**
 - **Selection index** aligned with product profile
 - Best practice **trial analyses** to estimate breeding values and genetic merit
 - **Visualization tools** support decision-making
 - **Selection intensity and genetic diversity** considered in parent selection
- Impactful breeding pipeline**
 - A **defined pipeline** is established to deliver high-quality germplasm from first crosses to adapted varieties.
 - Sufficient data is generated and available to enable customer and growers to make **informed variety choices**
- Continuous improvement culture**
 - Full use of external trialing and germplasm
 - **Breeding teams are the experts**
 - Clear **pathway and metrics** to deploy new and successful breeding methods
 - **Annual review** of performance metrics
 - Respect and safety for **all employees**

<https://excellenceinbreeding.org/eib-annual-meeting/day-1>



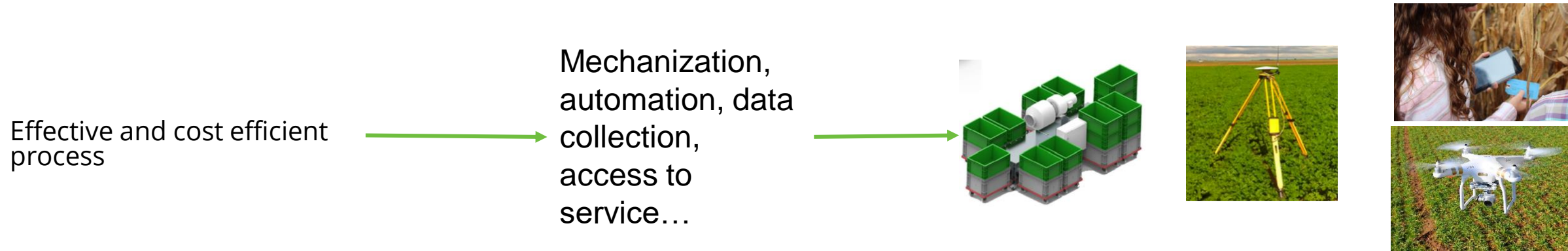
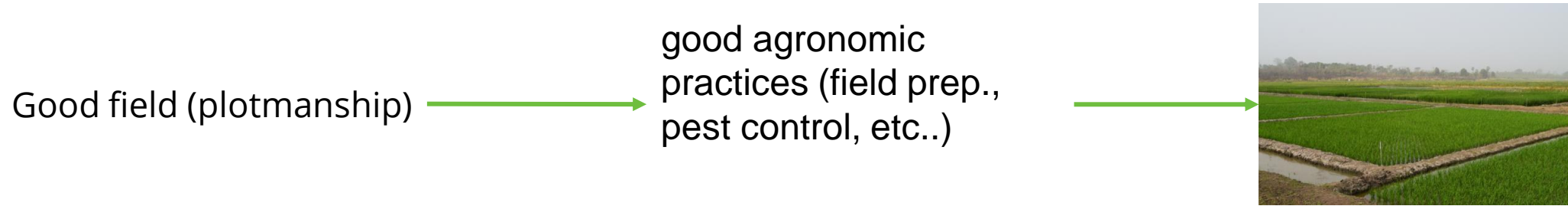
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What does it mean?



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What does it mean?



What does it mean?

Continuous Improvement



Health, Safety and environment





What is the current status?



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Breeding operations assessment



1. Agronomic practices

2. Seed processing

3. Planting and harvesting

4. Phenotyping

5. Continuous improvement

25 research stations

National Programs

CGIAR

Ranking



Stations visited received a report ranking the current status of each sub-category ranging from Marginal to Cutting-edge.

The table on the right illustrates the current status of agronomic practices in Breeding Operations across CGIAR centers.

CG system

Category	Subcategory	Station / Program	Current Status				
			Marginal	Basic	Good	Better	Cutting-edge
Agronomic Practice	Field preparation, fertility, IPM, and crop maintenance equipment	A					
		B					
		C					
		E					
		F					
		G					
		H					
		I					
		J					
		K					
		L					
		M					
		Agronomic Practice	Irrigation and Weather Data	A			
B							
C							
D							
E							
F							
G							
H							
J							
K							
L							
M							
Agronomic Practice	Farm Management System			A			
		B					
		C					
		D					
		E					
		F					
		G					
		H					
		I					
		J					
		K					
		L					
		M					
Agronomic Practice	Greenhouses and Controlled Environment	A					
		B					
		C					
		D					
		E					
		F					
		G					
		H					
		I					
		J					
		K					
		L					
		M					

Current status of agronomic practices across CGIAR centers

Category	Subcategory	Station / Program	Current Status			
			Marginal	Basic	Good	Cutting edge
Agronomic Practice	Field preparation, fertility, IPM, and crop maintenance equipment	A				
		B				
		C				
		D				
		E				
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					
	Irrigation and Weather Data	A				
		B				
C						
D						
E						
F						
G						
H						
I						
J						
K						
L						
M						
Farm Management System	A					
	B					
	C					
	D					
	E					
F						
G						
H						
I						
J						
K						
L						
M						
Greenhouses and Controlled Environment	A					
	B					
	C					
	D					
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Agronomic Practices

Category	Subcategory	Station / Program	Current Status			
			Marginal	Basic	Good	Cutting edge
Planting / Harvesting	Planters / Planting Solution	A				
		B				
		C				
		D				
		E				
	F					
	G					
	H					
	I					
	J					
Plot Combine / Harvesting Solution	A					
	B					
	C					
	D					
	E					
F						
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I						
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M						

Planting and harvesting

Category	Subcategory	Station / Program	Current Status			
			Marginal	Basic	Good	Cutting edge
Phenotyping	Phenotyping	A				
		B				
		C				
		D				
		E				
		F				
		G				
		H				
		I				
		J				
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L						
M						

Phenotyping

Category	Subcategory	Station / Program	Current Status			
			Marginal	Basic	Good	Cutting edge
Seed Processing / Conditioning	Seed Process Infrastructure	A				
		B				
		C				
		D				
		E				
	F					
	G					
	H					
	I					
	J					
Conditioning, Packaging and Treating	A					
	B					
	C					
	D					
	E					
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Seed Processing

Category	Subcategory	Station / Program	Current Status			
			Marginal	Basic	Good	Cutting edge
Continuous Improvement	Continuous Improvements / HSE	A				
		B				
		C				
		D				
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Continuous Improvement



How can we make the transition?



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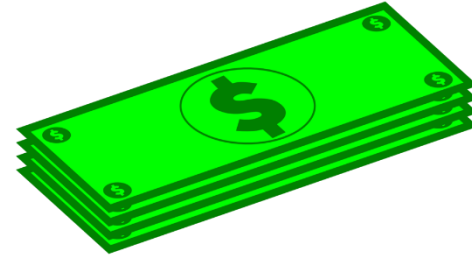
There are many aspects to consider...



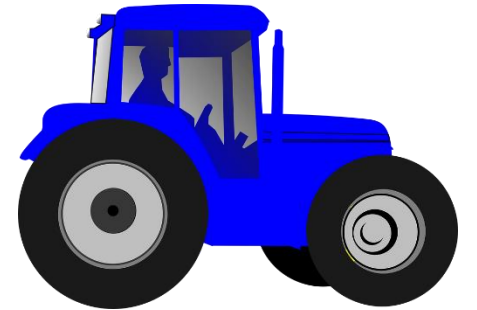
Management



Institutional



resources



technical



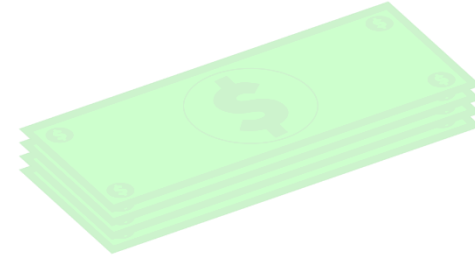
is about...



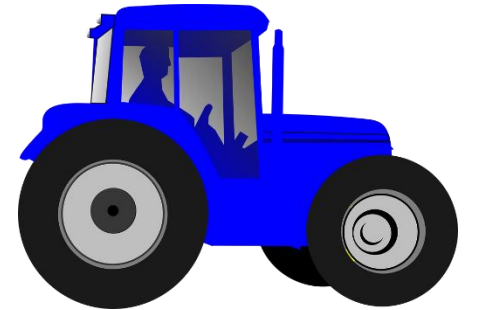
Management



Institutional



resource



technical



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If we have opportunities to improve....



There are many good practices to share.....



What is BOND ?



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Breeding Operations Network for Development (BOND)



Promote the development of skills and mechanization techniques among the employees of the different research centres of CGIAR & NARS improving the heritability of breeding trials



How would this program work?



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BOND Pillars

most effective and cost efficient phenotypic process/ Quality data/ Safe workplace

Increase the use of mechanization, automation, precision and high-throughput phenotyping tools

**BOND 1.o.1
interaction
group**

**BOND
webinars**

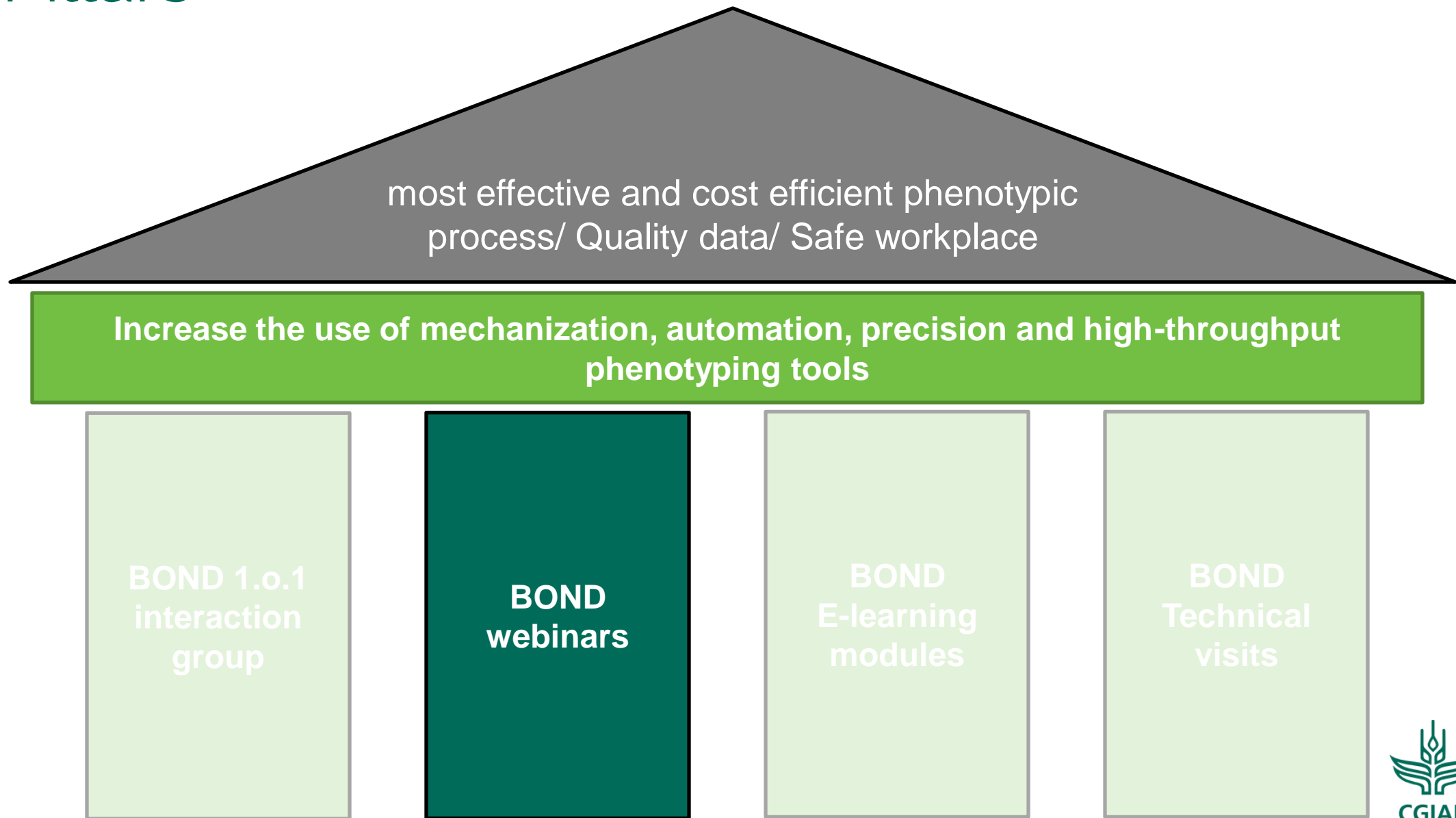
**BOND
E-learning
modules**

**BOND
Technical
visits**



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Pillars





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